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(54) A METHOD OF STRENGTHENING EDGES OF FIBROUS SHEET MATERIAL

(71) We, JOHNS-MANVILLE CORPORATION, a corporation organized under the laws of the State of New York, United States of America, having a place of business at Greenwood Plaza, Denver, Colorado, 80217, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method of strengthening the edges of fibrous sheet material.

Felted mineral wool boards and, to a lesser extent, mineral wool boards produced by a casting, rather than a felting process, are low in density by design. This is to provide an internal structure that promotes absorption of sound when the surfaces are open to the penetration of sound waves by the presence of perforations. The low density and other structural characteristics of these boards that make them suitably efficient as sound absorbing elements do not, at the same time, lead to high strength, ruggedness and resistance to mechanical damage, particularly along edges that are exposed to nicks and bumps in the course of handling and installation.

Often, the boards are fabricated into panels for installation as acoustical-decorative ceilings by laying the panels into a suspended grid system. Hence, accidental damage to the fragile edges of the panels are concealed to a considerable, but not unlimited, extent by the supporting grid elements upon which the panels rest. However, this concealment of accidental edge damage is not achieved when the boards are fabricated into tiles which are installed with either a kerf-and-spline system or with a tongue-and-groove construction. Since adjacent tiles are abutted directly against each other, accidentally damaged edges are conspicuous and aesthetically objectionable. Some tiles are produced with bevelled edges and are therefore slightly, but not extremely, tolerant of such edge damage. Other tiles, that are produced with a square cut (i.e., non-bevelled) edges, to simulate a monolithic appearance in a ceiling, are extremely non-tolerant of any edge damages, which introduce breaks that prevent the achievement of the desired monolithic effect.

In addition to the described disadvantages of damage along edges, the fragility of the fissured surfaces at some distance from the edges also leads to visually objectionable damage. In earlier (and some current) industrial practice, mineral wool-containing compositions of paste-like consistency were cast in large pans and screeded to a level condition. In the process of screeding, portions of the surfaces were pulled out by the screeding implement, resulting in the natural, but uncontrollable, introduction of surface fissures which became a distinguishing and desired characteristic of this class of acoustical product.

Since the felting process of producing mineral wool acoustical boards makes no use of a screeding step, the resulting surfaces have no natural fissures, and the desired fissured appearance must therefore be produced artificially by punching the surface with suitably shaped metallic elements. This process of puncturing the dry surface with suitably shaped metallic elements, and then withdrawing those elements, results in substantial weakening of the felted board surface. It is thus often seen that even with ordinary handling of the final painted products, portions of the weakened surface break away and fall off, leaving undesirable areas to irregularity and color contrast on the surface.

In a common example of standard industrial practice, felted mineral wool boards are planed on the exposed side and then prime coated with a filling-leveling composition consisting predominantly of a dispersion of clays and a minimal proportion of an organic binder in an aqueous medium. After this coating has been dried, the boards are cut up into the desired sizes of panels and tiles, the tiles being further machined into the desired edge configurations. Normally, they are then coated with an emulsion type opaque white coating applied by spray equipment or curtain coater and finally dried and packaged.

Demands for maximum filling and surface levelling properties in the case of the above-mentioned primer, and for maximum opacity and economy in the case of the typical white coating, normally dictate the use of high filler and pigment content and very low organic binder content in both of these coating compositions. Hence, their combined effect as contributors to the strengthening of edges and surfaces is therefore very small.

From the foregoing, it should be apparent that there is a great need for strengthening the external surface, and particularly the edges, of fibrous acoustical sheet material, especially when the sheet material is used in the formation of acoustical tiles and/or panels which, when assembled, have their edges exposed to view. However, most of the acoustic tile and panels provided heretofore have not displayed the satisfactory strength required to eliminate or minimize the aforedescribed damage. While some sheet material includes a coating of protective resin, this resin has been applied in solution form. Where the sheet material is a low density acoustical material, this solution causes uncontrollable deep penetration of the resin solution and very little hardening protection to the outer surface and especially the edges of the material. In addition, in many cases, the resin has been applied to the edges of the sheet material with rollers having a steel or otherwise hard applicating surface. Engagement between the edges and hard applicating surface has in many cases contributed to damage of the edges.

According to the present invention there is provided a method of strengthening edges of a fibrous sheet material comprising applying a protective resin to said edges with a roller and thereafter curing said resin to provide hardened strong edges wherein said resin is an emulsion containing a polymeric resin, a curing agent, and a dispersing medium, said roller has a resilient and porous circumferential edge for contacting the edges of said fibrous sheet, and after the application of said resin to said edges said edges are heated to remove said dispersing medium and to cure said resin.

The invention will now be described by way of example with reference to the accompanying drawing in which:—

Figure 1 is a plan view of an assembly for applying an emulsified polymeric resin to the edges of sheet material;

Figure 2 is a perspective view of a roller arrangement utilized in the assembly of Figure 1; and

FIG. 3 is a sectional view taken generally along lines 3-3 in FIG. 2.

The present invention is directed to a novel method of strengthening the edges of fibrous sheet material, especially fibrous acoustical sheet material such as, for example, felted mineral wool boards or other such boards displaying the low density and high absorption characteristics required by acoustical boards. An arrangement of rollers, which are resilient and porous, are used to apply an emulsified polymeric resin, preferably a thermosetting acrylic polymer, to the edges of the sheet material. In addition to the polymeric resin, that is, the dispersed phase, the applied emulsion includes a dispersion medium, preferably water, and may also include a compatible dispersant or emulsifier. The dispersion medium comprising part of the emulsion is removed from the applied emulsified resin for providing a protective edge coating which is surprisingly much harder than the untreated edges of a similar board.

In accordance with the present invention, the resin must be in an emulsified state upon application thereof. In this regard, it has been found, for example, that solutions of the resin tend to penetrate uncontrollably the sheet material, especially low density fibrous acoustical sheet material, leaving an unsatisfactory protective coating.

Turning to the drawing, where like components are designated by like reference numerals throughout the various figures, attention is directed to FIG. 1 which illustrates an assembly 10 for applying an emulsified polymeric resin and a polymer cross-linking or curing agent to opposite edges 12 and 14 of felted mineral wool containing boards 16. As illustrated, the assembly includes a conventional conveyor arrangement 18 (see Figure 1) which may be, for example, a suitable chain belt arrangement for moving the boards 16 along a predetermined straight line path, as indicated by arrows 20. A pair of resin applying roller arrangements 22 are positioned on opposite sides of conveyor arrangement 18 for applying the emulsified polymeric resin and curing agent to edges 12 and 14 of each board 16 as the latter

passes therebetween. In this regard, it should be noted that edges 12 and 14 extend out beyond the sides of conveyor arrangement 18 where, as will be seen hereinafter, they engage against rollers of arrangements 22.

After boards 16 located on conveyor arrangement 18 have been coated along edges 12 and 14, they are suitably transferred to a second conveyor mechanism (not shown) which extends perpendicular to mechanism 18 and which includes identical resin applying arrangements 22 positioned on opposite sides thereof. In this manner, the edges 24 and 26 of each board 16 may be resin coated in the same manner as edges 12 and 14.

In order to provide a finished acoustical product from mineral wool containing boards 16, the boards 16 are subjected to additional conventionally known processes apart from the aforedescribed edge coating process of FIG. 1. For example, each of the boards is generally planed on its ultimately exposed side prime coated with a filling-levelling composition and ultimately coated with an emulsion type opaque white coating or other such outer coating. In a preferred method, the edge hardener is applied after the planing and filling-levelling steps but before application of the final outer coating. However, the edge hardener could be applied right after the planing step or after applying the outer opaque coating. Finally, after being edge treated and coated with the outer coating covering, the boards are dried, preferably by heating at a temperature equal to or in excess of 150°F. In this manner, if the emulsified polymeric resin is of a thermosetting type, the heat not only dries the exterior coating but also hardens the resin.

Turning to FIG. 2, attention is directed to one of the resin applying arrangements 22 which includes a horizontally disposed container 28 positioned just below and to one side of conveyor mechanism 18 (see Figure 1). The container is filled with an emulsified polymeric resin which, as stated above, is preferably but not exclusively a thermosetting acrylic polymer emulsion or an emulsified thermoplastic polymer of ethylenically unsaturated monomers. The container is also provided with a conventionally known resin curing agent. Container 28 includes a lip plate 30 which extends inwardly and upwardly at an angle from the top inner edge thereof. As will be seen hereinafter, the lip plate is provided for catching any excess resin applied to the edges of board 16 for directing the dripping resin back into container 28.

Arrangement 22 also includes a cylindrical applicating roller 32 having a resilient and porous circumferential edge 34 which is preferably constructed of polyurethane foam or nylon flock. In this manner, as the roller engages against the edges of boards 16, especially upon initial engagement thereof, the possibility of damage to the edges caused by engagement of the roller is minimized, hence, eliminating the aforedescribed damage-producing problems inherent with steel or otherwise hard rollers.

Roller 32 is axially fixed to one end of a drive shaft 36 extending through spaced-apart bearing clamps 38 which are bolted to a shaft supporting plate 40. As illustrated, plate 40 is supported over the outer top edge of container 28 by a vertically disposed plate member 42 suitably fastened at one end to the container and at its other end to the shaft supporting plate, the latter extending at an angle, preferably approximately 45°, with the inside vertical surface of support plate 42. Hence, drive shaft 36, which is parallel to shaft supporting plate 40, is, in a similar fashion, angularly positioned with respect to vertically disposed plate 42. In this manner, the roller 32 is disposed at an angle, preferably 45° with respect to the vertical, so that its lower edge extends into container 28 and its upper edge extends out of the container and over lip plate 30 for engagement with one edge of a passing board 16, as illustrated in FIG. 2.

In order to transfer the emulsified polymeric resin and resin curing agent within container 28 to an adjacent edge of the passing board, the roller 32 and connecting shaft 36 may be allowed to rotate freely within bearing clamps 38. In this case, engagement of edges 12 and 14 against corresponding adjacent rollers 32 as the board 16 moves along its predetermined path causes the rollers to rotate and thereby transfer the emulsified resin and curing agent to the edges. However, as illustrated in FIG. 2, the rollers may be positively driven by any suitable means, as generally indicated by the reference numeral 45.

In order to regulate the amount of emulsified resin and resin curing agent transferred from container 28 to the edges of boards 16, arrangement 22 includes a doctor blade 46 which includes two coaxial frusto-conical members 46 connected together, preferably integrally, at their smaller ends. The doctor blade, as will be seen below, is adjustably positioned against circumferential edge 34 of roller 32 and axially parallel with the latter for limiting the amount of material transferred from the container to the edges of the passing board.

Doctor blade 44 is rotatably mounted about a rotation pin 48 which, in turn, is connected with a doctor blade adjustment

arrangement 50 for adjustable movement towards and away from circumferential edge 34. Arrangement 50 includes a horizontally extending rod 52 which is positioned just above container 28 and parallel with the movement of board 16. The rod, which is threaded at opposite ends, is disposed at one end in a cooperating threaded aperture provided through a vertically disposed support plate 54 mounted to one end of container 28. A handle 56 is suitably fastened to this end of rod 52. The otherwise free end of rod 52 is disposed within an aligned threaded aperture provided in a movable member 58 positioned on a support plate 60 mounted to the interior of container 28. The pin 48 which supports doctor blade 44 for rotation is, in turn, suitably fixed to movable member 58. Hence, as illustrated best in FIG. 3, upon rotating handle 56 and therefore rod 52 in one direction, the movable member 58 and therefore doctor blade 44 moves parallel with the axis of the rod and either towards or away from the circumferential edge 34 of roller 32, depending upon the direction of rotation. In this manner, the amount of pressure applied to the roller by the doctor blade can be varied for regulating the amount of material transferred from container 28 to the edge of board 16.

From the foregoing, it should be readily apparent that the edges 12 and 14 of board 16 passing between arrangement 22 are coated with a regulated amount of emulsified polymeric resin and resin curing agent. As stated above, this emulsified resin is preferably a thermosetting acrylic polymer emulsion or emulsified thermoplastic polymer of ethylenically unsaturated monomers. The circumferential edge 34 of roller 32 is of a resilient and porous material, preferably a polyurethane foam or nylon flock. In this manner, the emulsified resin can be applied to the edges of board 16 in a uniform fashion while minimizing the possibility of chipping to the edges due to engagement of the latter with the rollers.

As stated above, boards 16 are preferably of a fibrous acoustical type including mineral wool. In this regard, as also stated above, acoustical boards of this type are often provided with fissures throughout their surface to enhance acoustic characteristics. In order to prevent the boards from chipping or otherwise becoming damaged around the fissures, they may be coated with the aforedescribed emulsified resin so as to provide the same hardening effect as at edges 12 and 14.

While the present invention is especially suitable for use with relatively soft fibrous acoustical sheet material, it is to be understood that sheets of other material may be equally coated to provide the aforedescribed hardening effect. In this regard, the edges of two substantially identical boards have been tested for hardness. One of the boards was treated with an emulsified thermosetting polymeric resin in the aforedescribed manner while the other board was left untreated. Approximately 0.22 to 0.28 grams of resin (dried) was applied per square inch of area. The test consisted generally of chipping both the treated and untreated edges of respective boards and determining exactly how much pressure was required in doing this. It was found that to provide a chip in the untreated board required between 1-3/4 and 2-1/2 lbs. while it took between 3-1/2 to 5 lbs. in order to provide substantially the identical chip in the treated board. Hence, by treating the edges of the board in the aforedescribed manner, an excellent protective coating was provided.

WHAT WE CLAIM IS:—

1. A method of strengthening edges of a fibrous sheet material comprising applying a protective resin to said edges with a roller and thereafter curing said resin to provide hardened strong edges wherein said resin is an emulsion containing a polymeric resin, a curing agent, and a dispersing medium, said roller has a resilient and porous circumferential edge or contacting the edges of said fibrous sheet, and after the application of said resin to said edges said edges are heated to remove said dispersing medium and to cure said resin.

2. A method as defined in Claim 1 wherein said resin is a thermosetting acrylic polymer.

3. A method as defined in Claim 1 wherein said resin is a polymer of ethylenically unsaturated monomers.

4. A method as defined in any one of Claims 1-3 wherein said resilient and porous circumferential edge is constructed of a polyurethane foam or nylon flock.

5. A method of strengthening edges of a fibrous sheet material, said method being substantially as hereinbefore described with reference to the accompanying drawings.

6. A fibrous sheet material having edges thereof strengthened in accordance with the method defined in any one of Claims 1-5.

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1,394,621 COMPLETE SPECIFICATION
1 SHEET
This drawing is a reproduction of the Original on a reduced scale.

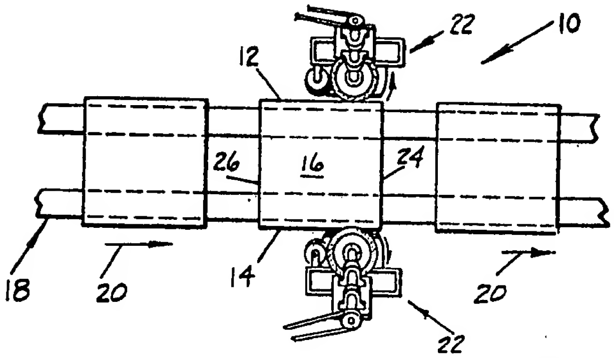

Fig. 1

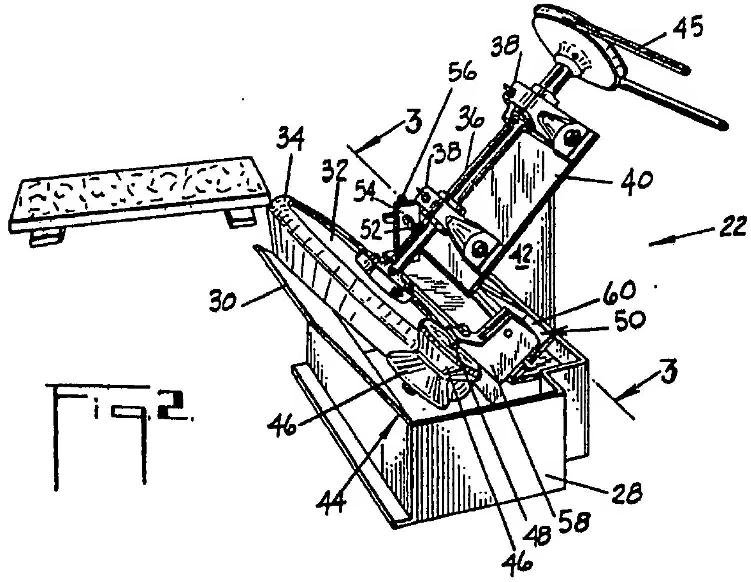

Fig. 2.

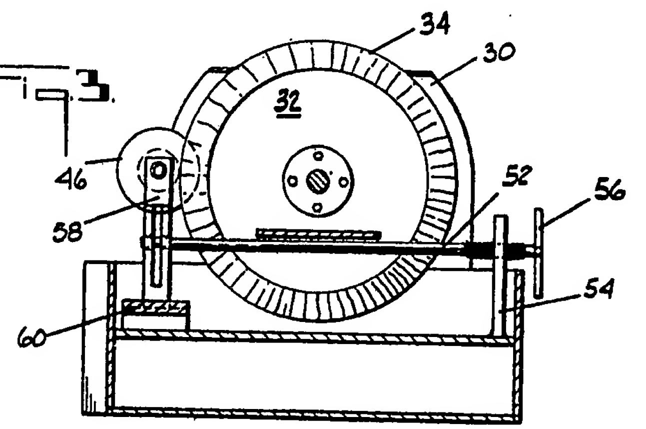

Fig. 3.